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## DISCLAIMER

# More with less.

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## ABSTRACT

Acceleration of D&D, integration of D&D, packaging, transportation and waste disposal and the challenging of waste disposal techniques has resulted in effective, efficient and cost effective solutions for LLW disposal at the Savannah River Site (SRS). Moving on from "Making it Happen" (WM03), SRS is now achieving "More with Less".

This paper will identify the benefits from building diversity into the approach for D&D, waste form selection, packaging, transportation and options for disposal. It will describe these cost effective and innovative techniques not previously used at SRS and which may benefit the rest of the DOE complex.

## INTRODUCTION

BNG America Savannah River Corporation is the managing contractor for the Savannah River Site, Solid Waste Management Contract and is a member of the best in class team that has achieved a demonstrably remarkable acceleration of the waste disposition mission at SRS, since assumption of the Site M&O contract in 1996.

This success in accelerating the waste disposition mission has resulted in the processing, treatment and disposition of legacy radioactive waste including off site shipment for permanent geological disposal. In addition a significant number of redundant facilities which were not required for the continuing mission at SRS have either been demolished or placed in care and maintenance for re-use. The decision to prepare a facility for re-use is typically made for the larger heavily shielded facilities such as Canyons which represent a significant capital investment.

Much of the success has been achieved using baseline technology to prosecute an aggressive schedule that was end point driven. For the SRS Site this meant a revaluation of the clean up end points and a realization that low cost, efficient final disposal of legacy radioactive waste was the ultimate project driver. Decommissioning and Waste Management projects are all driven by waste handling, transport and disposal costs. Therefore, selection of the most appropriate disposal path is key to establishing a safe, low cost and efficient project. Developing a remediation strategy that works back from the disposal criteria to design the process steps of the project has been shown to be both safer and more cost effective than previously employed strategies.

The activity of developing project end points that are driven by waste disposal criteria is not as simple as it appears and at SRS it required a fundamental revaluation of the Site performance assessment,

regulatory drivers and operational practices. The Contractor cannot achieve this alone and therefore one of the enabling tools employed at SRS was communication to inform the decision making process. This took the form of establishing a dialogue with the Stakeholders, South Carolina Department of Health and Environmental Control (SCDHEC) the South Carolina Governor's office, Department of Energy (DOE), the Nuclear Regulatory Commission (NRC) and of course the public using the vehicle of the SRS Citizens Advisory Board (CAB) and the Environmental Protection Agency (EPA) region IV.

Many of the decisions required to accelerate waste disposition projects are complex, highly technical and impact the whole SRS mission and therefore cannot be made unilaterally. To that end, subject matter experts were employed to assist the Stakeholders in developing an understanding of technical issues, sometimes these were individuals and sometimes independent review bodies. Whichever the case, it is of paramount importance that the flow of information is in the form of an open dialogue that fosters informed consensus in the decision making process and not majority ownership of decisions by the most informed.

A number of project successes are reviewed in this paper and all have been a result of changing the decision making process through informed dialogue, to achieve end states that are safer, lower cost and result in meeting project milestones for waste disposition many years ahead of previously agreed project milestones. Briefly these are :

- The Transuranic Waste Management Program
- Disposition of previously designated Orphan Waste
- On Site LLW disposal
- Incorporation of Small Quantity Sites TRU waste into the SRS TRU waste Program
- Disposition of Heat Source Plutonium Waste
- Innovative packaging of LLW for disposal

## THE TRANSURANIC WASTE MANAGEMENT PROGRAM.

BNG America, Savannah River Corporation, the operating contractor for the Waste Management Area Project at SRS, is responsible for the retrieval and disposal of TRU waste from the pads at SRS. The inventory of TRU waste that this project represents can be summarized as 11,650 cubic meters of legacy inventory, containerized in the following:

- 30,000 55 gallon galvanized carbon steel drums
- 2000 large boxes and non-drummed TRU waste containers

Containers range in fissile inventory from 0.5 curies to 1,500 curies of weapons grade and heat source plutonium. The majority containers were considered mixed waste based upon the dates they were generated.

Container storage areas included earthen covered concrete pads containing drums, drums in culverts (higher activity) and large boxes, to Resource Recovery and Conservation Act (RCRA) regulated fabric covered buildings for drums and open storage for culverts and large boxes.

Starting in January 1997 through August of 1999, over 8,800 drums of TRU waste were retrieved from earthen covered mounds, inspected vented and purged of radiolytic gases, and re-stored in aisle-spaced fabric covered buildings. This was a major project activity, completed two years ahead of schedule, eliminating concerns about the condition of these containers, which had been under earthen cover for over 20 years. Also these containers, all of which were produced prior to 1986, did not have filter vents installed in the drum lids.

As part of the retrieval program, all these containers were processed through the Drum Vent and Purge system, where radiolytic gas (primarily hydrogen) and other gasses such as methane and volatile organic compounds (VOC's) were vented and a carbon filter inserted to prevent the recurrence of gas accumulation. To date some 25,000 drums have been processed through this system (including non-retrieved drums).

In 1998, a Ship to WIPP effort was initiated with emphasis on developing the process, procedures and facilities to meet the requirements of the WIPP Acceptance Criteria and the New Mexico, RCRA permit. This included the installation of characterization facilities including headspace gas sampling and analysis and non-destructive assay and radiographic equipment. Existing facilities were modified to accept the TRUPACT-II loading platform. A new facility was constructed, the Visual Examination Facility, which provided verification of drum contents identified through radiographic analysis.

This facility is another example of "fit for purpose" capability provided at relatively minor cost by using existing infrastructure and equipment. All the information gained from retrieving and processing the drums prior to characterization was used to develop an Acceptable Knowledge (AK) report that is necessary to meet the WIPP shipping requirements. The site was successful in passing a certification audit in November of 2000. The first shipment of 42 drums was made on May 8th 2001. Since then, an additional 16,000 drums (over 500 shipments) have been made. The site anticipates that the shipment numbers will continue to increase with, disposition of all of the legacy TRU waste by 2009 - 2010.

Early completion of the legacy TRU waste retrieval and shipping mission at SRS by moving this waste into safe permanent disposal at WIPP by more than twenty years ahead of schedule, this represents a saving to the taxpayer of approximately $700 million. Subsequently, this brings the scheduled completion date forward by more than twenty years from the original baseline of 2034. This has been achieved through adoption of risk informed decision making to accelerate the safe and cost efficient clean up activity. All of this has been achieved without a single reportable safety event.

## DISPOSITION OF PREVIOUSLY DESIGNATED ORPHAN WASTE.

The SRS nuclear production reactors were water moderated units and careful control of water chemistry was a key operational requirement. This was achieved using mixed bed organic ion exchange units, one of the predominant species sequestered by the media was C-14, and as much as 740 GBq (20 curies) could

be entrained within each ion exchange unit. At these levels of C-14 the waste designated as "waste with no disposal path" because the on-site disposal vaults have limits of 160 GBq (4.3 curies) per vault.

The vault limitation of C-14 is based upon the site performance assessment for aqueous C-14 as carbonate and a gas phase model for atmospheric release from the vaults. Of the two, the gas phase model is the determining value for the egress of C-14 to the environment via a carbon dioxide pathway. A review of the performance assessment was conducted and a new model that examines the chemistry of C-14 in a cementitious matrix in a vault was developed.

Modeling of the C-14 gas phase in this environment showed the gas phase reaction was concentration limited by the kinetics of the release model. In other words, the rate of release of C-14 is limited by solubility irrespective of the source term. The performance assessment for the site which evaluates a 1,000 year release term from the vaults through the soil cap was used to demonstrate that both the atmospheric and aqueous C-14 release was bounded within the limitations set for the Maximally Exposed Individual (MEI) at the site boundary and within the 100 meter downwind location. In summary, it is concluded that the vaults are not C-14 concentration limited and all of the existing ion exchange legacy waste could be disposed of in the vaults.

Clearly the work performed to model the C-14 vault chemistry is technically complex and the resulting decision that challenges existing vault disposal limits attracts considerable attention from the Stakeholders. Consequently the risk informed decision making process that seeks to expose the decision to a rigorous review by the regulators, public and customer is a critical, worthwhile investment. In doing so it was possible to gain wide support for the technical case that allowed the safe and cost efficient disposition of this orphan waste, removing a significant source term from the ongoing care and maintenance environment.

## ON SITE LLW DISPOSAL

Following a period of evaluation by the EPA of the practice of disposing of LLW in trenches during the 1980's DOE sites moved to the construction of robust concrete vaults for the disposal of LLW. At SRS this decision was made in isolation of the ongoing performance assessment which reviewed the SRS source term and environmental impacts across the site. In doing so the vaults became the baseline disposal technique irrespective of the level of contamination. Following the disposal of a very large volume of suspect contaminated soil, over 1 million cubic feet per year, the decision to place all waste in the high integrity vaults was questioned.

Once again the mechanism of risk informed decision making was employed to evaluate the economic and environmental aspects of vault disposal against trench disposal, using the site performance assessment as an analysis tool. It was concluded that disposition of very low level wastes in vaults was costly and in fact the long term performance of LLW in trenches was found to be technically sound. Consequently the SRS site returned to the use of engineered trenches delaying the need to construct additional vault space for at least an additional decade. It was estimated that this environmentally robust option to utilise trenches saved approximately $63 million which could then be diverted to address more critical clean up goals at the SRS site.

## INCORPORATION OF SMALL QUANTITY SITES (SQS) TRU WASTE INTO THE SRS TRU WASTE PRGRAM

The National TRU program is an integrated program that seeks to accelerate the disposition of TRU waste from sites to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, for long term geologic disposal. Locally the SRS Ship to WIPP program has been a great success demonstrated by the schedule saving achieved in completing the mission to ship legacy TRU waste out of SC. That high level of competence and success allowed the SRS program to grow from a local site program into playing a key role within the National TRU program.

The growth of the SRS TRU program into one of national significance was achieved, once again, by informing the decision making process through interactive and open dialogue with the Stakeholder and public, to demonstrate that SRS could effectively receive and process TRU waste from other sites. The safe and efficient processing of TRU waste for ultimate geologic disposal requires an investment in capital equipment and infrastructure married to an expert group who develop, under a learn and repeat mechanism, to the point where considerable efficiencies can be realized.

This investment and development in people and process is considerable and for small sites undergoing closure present an economic and logistical challenge, two such sites were Mound and Battelle Columbus in Ohio. With relatively little TRU waste and an accelerated closure mission it was not credible to develop TRU programs for these sites. Therefore the SRS site through the work of the M&O contractor, the customer, Stakeholders and public was able to demonstrate the efficacy of receiving this TRU waste for subsequent processing. This was negotiated on the basis that for every curie of SQS waste that was received twice the quantity of SRS TRU waste would be dispositioned to WIPP for long term geologic disposal. Clearly this could only be achieved because of the robust success of the SRS TRU program and the confidence the Stakeholders and public shared in it.

## DISPOSITION OF HEAT SOURCE PLUTIONIUM

Operations at the SRS site over the past 30 years have generated both weapons grade Pu-239 and heat source Pu-238 plutonium contaminated waste. This waste was stored in 55 gallon drums (approximately 30,000) and in boxes (approximately 3000), the total volume being some 12,000 $m^3$ equally split between drums and boxes. The specific issues affecting heat source waste is its specific activity and heat generating capacity, on site experience has shown it to be 500 times more difficult to maintain airborne controls and has resulted in ten times more contamination incidents handling ten times less material than weapons grade waste.

Disposition of the heat source waste will require intrusive remediation of the drums and waste packages stored in concrete culverts, casks, oversize boxes and other non specific containers, in order to meet the WIPP waste acceptance criteria. In addition highly specialized characterization equipment is needed to assay this material in its oversize containers and high integrity facilities are required to perform the removal of prohibited items, a requirement of the WIPP WAC.

Recognizing the high hazard of handling this material and the direction for its long term disposal as defined in the WIPP Land Withdrawal Act and 40 CFR 191, the regulation that provides the requirements for disposal of TRU waste in a non-WIPP location. The SRS site is seeking to propose an innovative solution for disposition of heat source waste. The innovation is the specification of an alternate disposal option to WIPP, which demonstrates protection of human health and the environment under the performance assessment. This approach can within the stated regulations be sanctioned by the Department of Energy. Obviously a first step is to gain the confidence and concurrence for this strategy of the Stakeholders and public at SRS.

The new strategy is built upon recognition of the properties of heat source Pu-238 waste and the hazard that is presented in handling it. With a short half life of 88 years Pu-238 waste can be shown to meet LLW disposal performance objectives at the SRS site. Successful classification as LLW for on-site monitored disposal will realize benefits in both safety and cost and schedule for the disposition of this waste form. Specifically, it will :

- Reduce or eliminate the requirement to open the containers and handle the waste, thus significantly reducing the hazard posed in handling this material.
- Will significantly reduce the cost of robust environmentally sound disposal of PU-238 waste.

Moving forward with the decision will require demonstration that the strategy meets the expectations of the performance assessment (PA). The PA is simply an analysis of a radioactive disposal facility to show that the environment and public health are protected for the duration of the waste disposal facility operation after closure of the facility (DOE Order 435.1) This assessment evaluates exposure pathways for a number scenarios and sets acceptable exposure limits for the critical group via these pathways.

Performance assessment work completed to date has demonstrated that shallow land fill disposal in a cementitious waste form of the SRS Pu-238 waste meets the performance assessment goals. In summary by employing the same successful, risk informed decision process and fostering a full and open technical review, the SRS site will be able to demonstrate that employing an innovative TRU waste disposition strategy for its legacy heat source waste, will :

- Risk to the public and workers is eliminated by disposal in accordance with DOE 435.1 and 40 CFR 191.
- No waste containers will be required to be opened, thus greatly reducing radiological risks
- The scoping analysis fully demonstrates protection of the public and the environment for thousands of years.
- Safe cost efficient disposal of SRS legacy heat source waste at drastically reduced cost and bringing in the completion of the TRU waste program by decades.
- Innovative packaging of LLW for disposal

# INNOVATIVE PACKAGING OF LLW FOR DISPOSAL

Acceleration of the waste disposition project at SRS can be clearly seen in the decommissioning projects that have been completed and the rate at which projects are accelerating since FY 03. The fundamental change in D&D operations that has made this increase possible has been the change in waste disposal techniques for the massive amount of LLW generated by D&D operations. The volume of LLW generated by SRS D&D projects has increased in recent years by the following :

- Volumes doubled in 2003 from 10,000 to 20,000 $m^3$
- Volumes tripled in 2004
- Volumes quadrupled in 2005

This increase in production has been realized through the adoption of direct disposal of massive LLW from decommissioning into Strong Tight Intermodal containers. The Intermodal containers are refurbished, used containers designed specifically for one time use as transport and disposal containers. These containers are the 40 ft "sealand" containers, which at SRS have the desirable "top loading" characteristic. Previously B-25 boxes would have been employed and their considerably smaller size drove D&D projects into performing costly and time consuming size reduction operations in order to fit waste into the boxes.

D&D operations at SRS are targeting demolition of redundant facilities these are facilities that supported missions during the 1950's, typically these are pilot plants and supporting infrastructure and service buildings. This being so, the waste contains considerable amounts of massive concrete, the size reduction of which for disposal is of no benefit. There are 242 facilities slated for D&D during the time frame 2004 to 2006.

Size reduction of waste to fit B-25 boxes adds to the D&D project :

- Risk to workers
- Requires unique facilities and tooling
- Adds time and cost for no benefit.

Utilization of top loading Intermodal's bring to the D&D project :

- Tooling right sized for handling massive waste
- Reduced worker involvement in waste processing
- Rapid loading, typically a 40' Intermodal can be filled in 1 hour
- Reduced schedule and cost
- Increased packaging efficiency by reducing voidage attributable to multiple smaller waste boxes.

An example of these efficiencies is the uranium contaminated M-area where buildings were demolished and loaded into Intermodals for disposal, and shipped in one week. Project estimates based upon the use of B-25 boxes predicted in excess of 3 months for this task.

Achieving the transition to the use of Intermodals required, once again, changes to established operating norms at the SRS site and again the application of baseline technology integrated into an informed decision making process was the tool employed to prosecute the changes. The performance assessment was revised, enhanced characterization techniques for the larger waste containers were developed, revised nuclear safety evaluations were performed, which resulted in the development and implementation of an optimized waste packaging and transport operation.

The efficiencies realized are summarized as :

- Fewer packages, therefore reduced paperwork to manifest waste, transport cost to ship it and handling costs to dispose of it.
- Fewer Characterization evolutions and associated underpinning QA documents
- Reduced procurement costs as fewer containers are needed, estimated at $3 -$4 million for FY 04 - 06
- Utilizes previously used transport Intermodals, which are refurbished for use as disposal containers in the nuclear industry
- Supplied by Associated Container of Goose Creek SC, a local company supporting the site with the capabilities to supply Intermodals to SRS using a "just in time" philosophy.

The use of Intermodals at the SRS site supporting D&D operations has allowed considerable cost savings and dramatically reduced D&D schedules, but perhaps most importantly it has enhanced safety by reducing worker involvement in the D&D process.

## CONCLUSIONS

The Savannah River Site continues to accelerate its waste disposition mission achieving "more with less" through implementation of innovative ideas to address clean up challenges. These innovations typically employ mature baseline technology to enable the development of radically different approaches, sometimes these are technically complex and sometimes they appear to challenge regulatory instruments.

At the Savannah River site the prosecution of innovative approaches to accelerate clean up and enhance safety at reduced cost, has been enabled through application of a process that seeks to involve the Stakeholders and public in the decision making process. Informing the decision making process through full and open dialogue, supported by carefully selected subject matter experts and review panels has enabled a number of very innovative solutions to be implemented.

There is little doubt, based upon the experience at the Savannah River site, that informing the decision making process and engaging the Stakeholders and public in resolution of complex and challenging issues has been a great success. Without that involvement and confidence the M&O contractors at DOE sites will continue have difficulty presenting innovative solutions that challenge established norms.

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